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January 31, 2005

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APPLICATION NUMBER: ***60/541,296***
FILING DATE: ***February 03, 2004***

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

H. L. JACKSON
Certifying Officer

PTO/SB/16 (05-03)
Approved for use through 4/30/2003. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

Express Mail Label No. EV 334814339 US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Shai	Abramson	Beit-Herut, Israel

☐ *Additional inventors are being named on the _____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

ROBOT DOCKING STATION AND ROBOT FOR USE THEREWITH

CORRESPONDENCE ADDRESS

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 12 ☐ CD(s), Number

☐ Drawing(s) *Number of Sheets* ☐ Other (specify)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☒ Applicant claims small entity status. See 37 CFR 1.27.

☒ A check or money order is enclosed to cover the filing fees

FILING FEE AMOUNT ($) 80.00

☒ The Director is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 50-1662

☐ Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____.

Respectfully submitted,

SIGNATURE _____ Date 2/3/2004

TYPED or PRINTED NAME Jerome R. Smith, Jr. REGISTRATION NO. *(if appropriate)* 35,684

TELEPHONE 816-360-4119 Docket Number: 67014

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop Provisional Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 80

Complete if Known	
Application Number	
Filing Date	Herewith
First Named Inventor	Shai Abramson
Examiner Name	
Art Unit	
Attorney Docket No.	67014

METHOD OF PAYMENT *(check all that apply)*

☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 50-1662

Deposit Account Name: Polsinelli Shalton & Welte

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	80

SUBTOTAL (1) ($) 80

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee from below		Fee Paid
Total Claims		- ** =	0	X		=	0
Independent Claims		- ** =	0	X		=	0
Multiple Dependent				X		=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above*

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive – unavoidable	
1453	1,330	2453	665	Petition to revive – unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17 (q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
				Other fee (specify)	

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($) 0

SUBMITTED BY				Complete *(if applicable)*	
Name (Print/Type)	Jerome R. Smith, Jr.	*Registration No. (Attorney/Agent)*	35,684	*Telephone*	816-360-4119
Signature				*Date*	February 3, 2004

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CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)			Matter No. 67014	
Applicant(s): S. Abramson				
Serial No. Not Yet Assigned	Filing Date Herewith	Examiner Not Yet Assigned	Group Art Unit Not Yet Assigned	Confirmation No. Not Yet Assigned

Invention: ROBOT DOCKING STATION AND ROBOT FOR USE THEREWITH

I hereby certify that a Transmittal (2 pages, in duplicate); Fee Transmittal (1 page, in duplicate); a Provisional Application for Patent, 12 pages total (including a 10-page specification, 2 pages of claims) Check No. 284702 in the amount of $80.00 (filing fee); a Certificate of Mailing by Express Mail (1 page); authorization to charge any fees, except the filing fee, which may be required to Deposit Account No. 50-1662; and a stamped, pre-addressed postcard are being mailed by U.S. Postal Service Express Mail to Addressee: Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, this 3rd day of February, 2004.

Gayle Canfield
(Typed or Printed Name of Person Mailing Correspondence)

Gayle Canfield
(Signature of Person Mailing Correspondence)

EV 334814339 US
("Express Mail" Mailing Label Number)

PATENT
Atty Docket No. 67014
Express Mail Label No. EV 334814339 US

UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	S. Abramson	Group No.	Not Yet Assigned
Serial No.:	Not Yet Assigned	Examiner:	Not Yet Assigned
Filing Date:	Filed Herewith	Confirmation No.	Not Yet Assigned
For:	ROBOT DOCKING STATION AND ROBOT FOR USE THEREWITH		

Mail Stop Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL

Dear Sir:

Attached hereto and transmitted herewith are the following:

- ☒ A Provisional Application for Patent Cover Sheet (1 page)
- ☒ A Fee Transmittal for FY 2004 (1 page, in duplicate)
- ☒ A Provisional Application for Patent, 12 pages total (including 10-page specification; 2 pages of claims)
- ☒ Check Number 284702 in the amount of $80.00
- ☒ A Certificate of Mailing by Express Mail (1 page)
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I hereby certify that, on the date shown below, this correspondence is being

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MAILING

37 C.F.R. §1.8
☐ as first class mail.

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FACSIMILE TRANSMISSION

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Gayle Canfield — Name of Depositor

Gayle Canfield — Signature

February 3, 2004 — Date

PATENT
Atty Docket No. 67014
Express Mail Label No. EV 334814339 US

The Commissioner is authorized to charge any additional fees, which might be required, to Deposit Account No. 50-1662. A duplicate copy of this transmittal is attached.

Respectfully submitted,

POLSINELLI SHALTON & WELTE, P.C.

Date: 3 Feb. 2004

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29421 / 67014
JRSMI 1070438

ROBOT DOCKING STATION AND ROBOT FOR USE THEREWITH

Technical Field

The present invention is directed to robotics. In particular, the present invention is directed to docking stations for robots that are of use outdoors, and for robots for use with these docking stations, such as robots that function as lawn mowers.

Summary

The present invention provides a docking station for a robot, such as a robotic lawnmower. The docking station is particularly suited for outdoor use, but can also be used indoors if desired.

An embodiment of the present invention is directed to a robot having at least one contact (for example, typically two contacts), at least a portion of the contact extending from the robot, a control system in communication with the at least one contact, and a power supply (for example, a battery or batteries) for the robot. The power supply is electronically linked to the control system and the at least one contact. The control system is configured for permitting recharging of the power supply (battery or batteries of the robot) through the at least one contact, when a predetermined voltage on the at least one contact is detected. The robot can be, for example, a robotic lawnmower. The predetermined voltage is at least a threshold voltage, that is, for example, at least 25 Volts.

Another embodiment of the present invention is directed to a docking station for a robot. The docking station has a portion configured for receiving a robot, and a system for providing power to the robot for recharging the robot. The system has receptors configured for contacting at least one docking contact (or contact) on the robot (the robot, for example, typically has two docking contacts or contacts) and transmitting a voltage therethrough. This voltage is typically at least a threshold voltage (for example, at least approximately 25 Volts) detectable by the control system of the robot that a docking contact has occurred, whereby the robot is now suitable for docking, as well as operations associated with docking, for example, recharging. The receptors include at least one leaf. For example, there are typically two leafs corresponding to each of the docking contacts

(or contacts) on the robot. The leafs are typically rigid and connected to a flexible suspension. The docking station also has a control system in communication with the power providing system. The control system is configured for communication with at least one tap of an irrigation system, the tap being timer controlled, and coupled with the receptor for sending a signal to the robot for initiating operation of the robot. The robot used with this docking station is, for example, a robotic lawnmower.

Detailed Description

Drawing Figs. 1-13 and their accompanying captions are part of this detailed description.

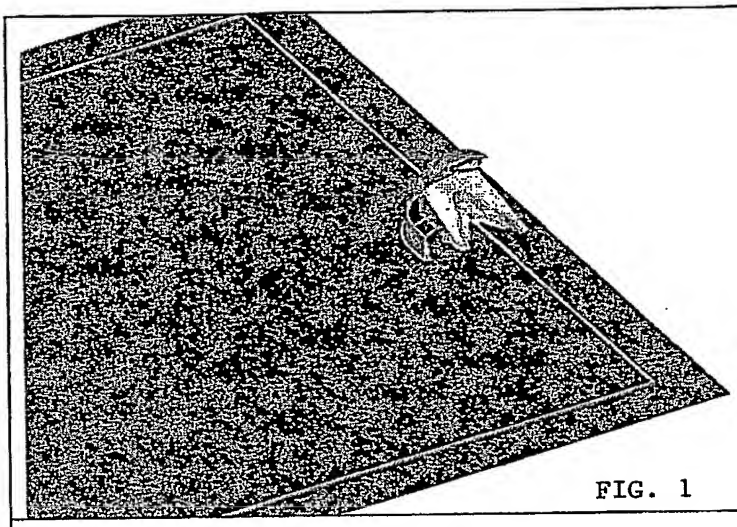

FIG. 1

The docking station is placed over the perimeter wire, and the robot can dock while following the wire (the 'edge' mode). The arc ('docking fence') prevent the robot from climbing the docking from the wrong direction during are scanning.

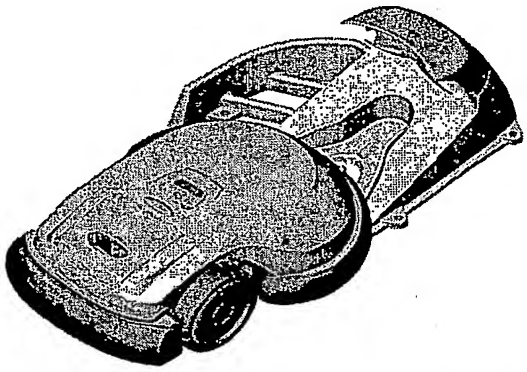

FIG. 2

When the robot reaches the docking station, and climbs the ramp, it first sense a 'drop off' event, when the front wheel drops in to the valley in the middle of the base..

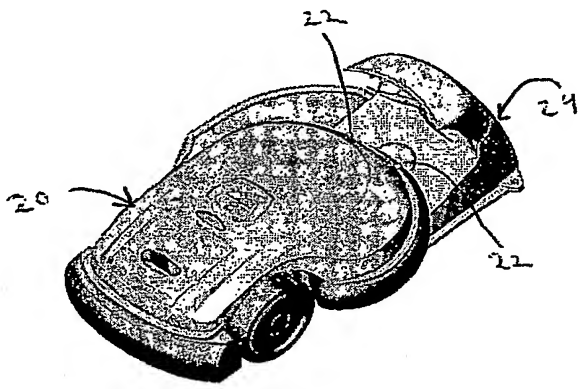

FIG. 3

The robot than continues to drive slowly, seeking for signal from the docking contacts when those touch the docking leafs. If a good contact has not been made, the robot will get a bumper event and will than back-off and try to re-dock.

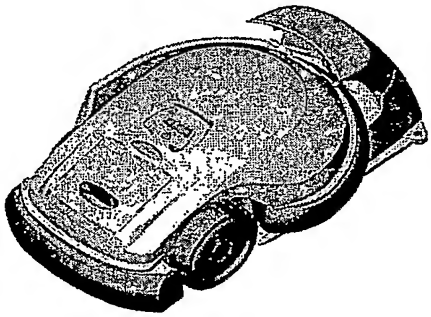

FIG. 4

When the robot sense a voltage over the docking contacts and stops, and starts the charging process.

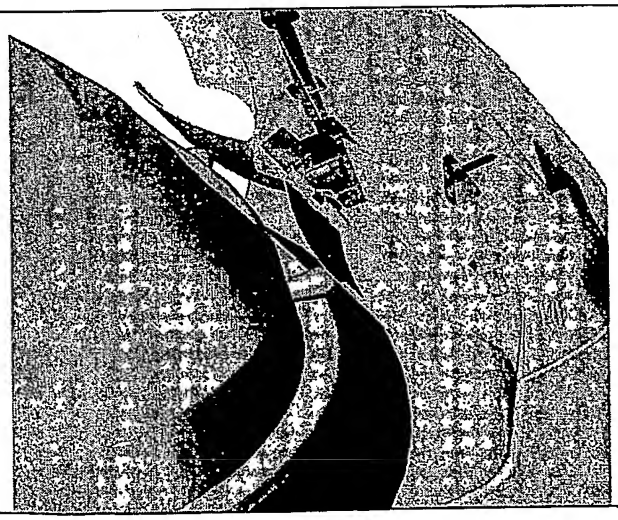

FIG. 5

The docking leafs are suspended in a manner the robot can both over travel after touching the contacts and also compensate for angular misalignments.

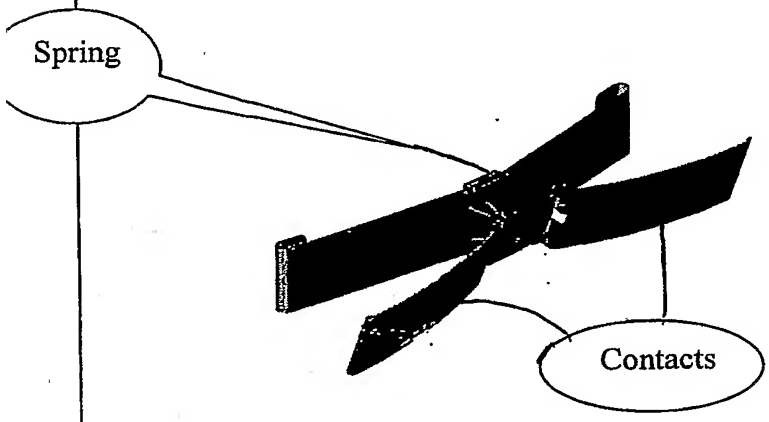

FIG. 6

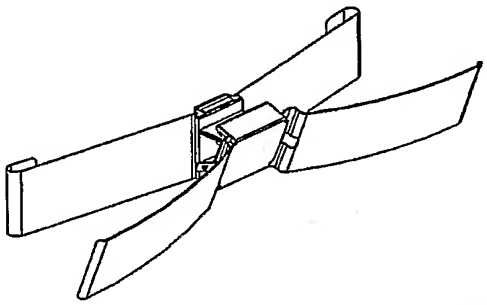

FIG. 7

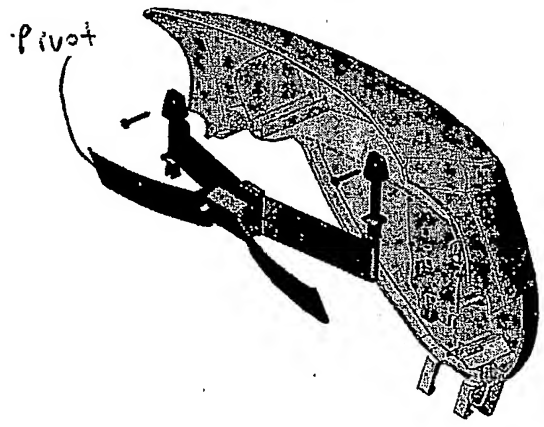

FIG. 8

The spring is held by 2 pivots.

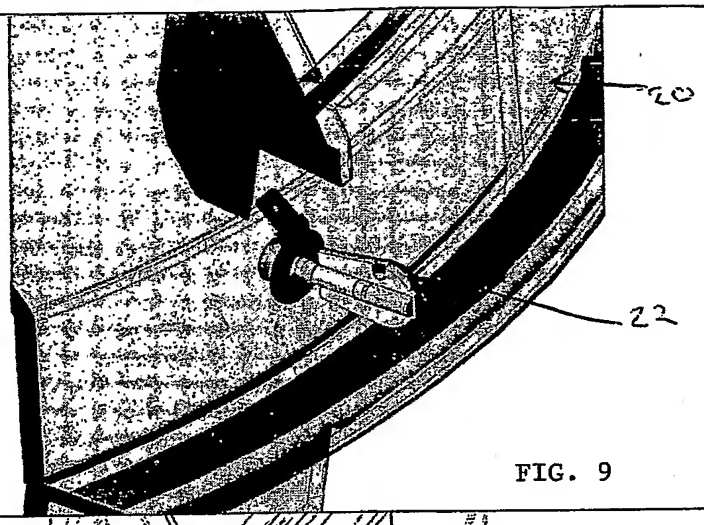

FIG. 9

The contacts on the robot are made of hollow stainless steel part. Inside the hole, a neodymium magnet is held by a screw and a small elastomer.

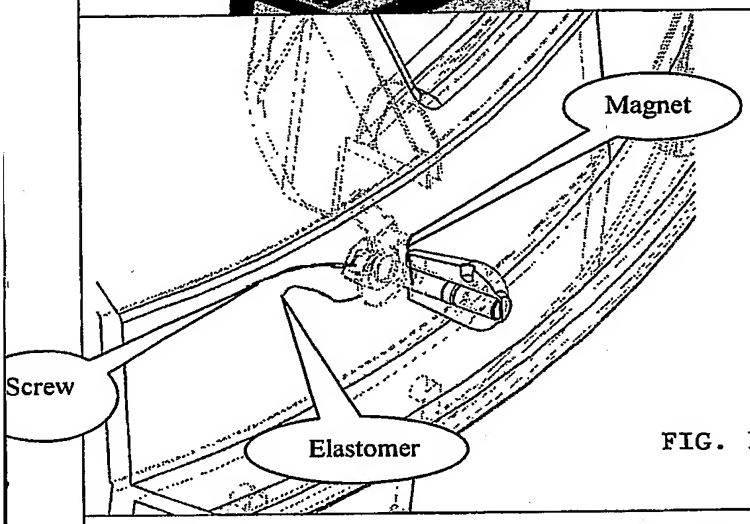

FIG. 10

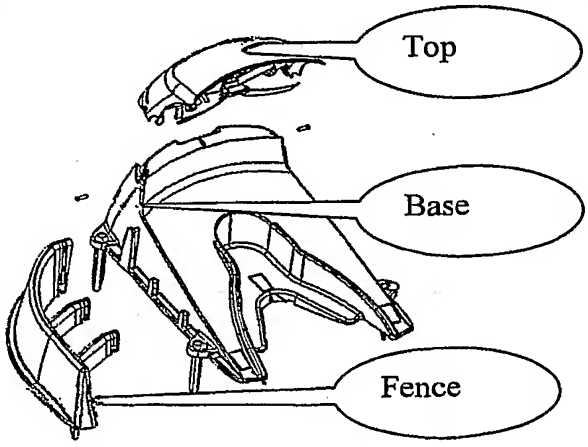

FIG. 11

The docking station is composed of a docking base, a docking fence, and a docking top that contains the contacts and electronics.

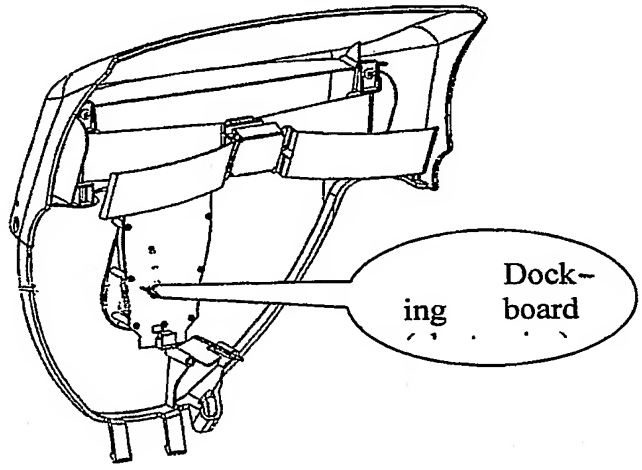

FIG. 12

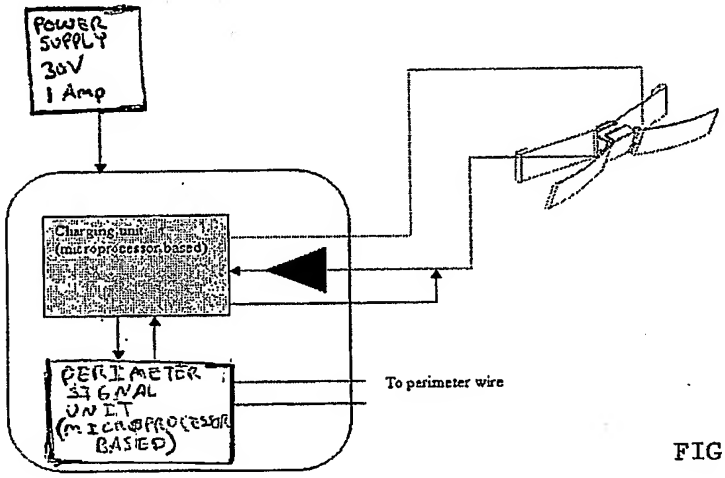

FIG. 13

Schematics of the docking board, composed of 2 units (perimeter signal generator and charging) that communicates with each other.
The charging leafs are switched to charging voltage only once a positive voltage is sensed across them (with comparator A) which is the case when the robot successfully docks.

A robot suitable for use with the docking station is a robotic lawn mower, for example, the robot disclosed in commonly owned U.S. Patent No. 6,443,509, incorporated by reference herein, and Robotic Lawnmower Model Numbers RL 500, RL 550, RL 800 and RL 850, from Friendly Robotics (the trading name of the owner of this application) of Pardesiya, Israel. All of the aforementioned robots are modified with docking contacts 22, for example, typically two docking contacts, at the front end of the robot, electronically linked (e.g., connected or coupled) to the control system (main control system) of the robot 20, and the power supply (batteries and associated components), to allow for charging of the power system once a sufficient contact is made (as determined by the control system, for example, there is at least a threshold voltage of, for example, as least 25 Volts, on the docking contacts 22), as shown, for example, in Figs. 3 and 9. Additionally, the front wheel of the robot is slideably mounted in a vertical orientation, such that when the mechanism on which the front wheel is mounted slides or drops downward to a predetermined level (also caused by lifting the body of the robot 20 at its front end), this mechanism is out of contact with a sensor, linked to the control system, whereby the control system signals the movement system (or drive system) to stop movement of the robot.

Detection of docking is initiated upon a 'drop off' event, that occurs when the unit or robot 20 climbs the docking base of the docking station 24 (Fig. 3). The climbing causes the front wheel, to drop downward, this dropping detected by the control system of the robot. The control system then signals the movement system (or drive system) to slow movement of the robot. The robot slows down and either a docking contact is made or there is a bumper event. If there is a docking contact, the docking contacts 22 are in contact with the leafs of the docking station, such that at least a threshold voltage (for example, at least 25 Volts) is then detected by the control system (activating the docking contacts 22). If this threshold voltage is not detected, there will be a bumper event (programmed into the control system by sensors on the bumper linked to the control system), where the robot 20 backs away from the docking station and attempts to redock. When there is a docking contact or bumper event, this is detected by the control system of the robot, that signals the drive (movement) system to stop.

The docking contacts are turned on (activated) by the charging voltage only when they sense a voltage (when the robot touches the docking contacts) of at least the threshold voltage (for example, at least 25 Volts). This prevents accidental shortening of the leafs when the robot is not docked. The perimeter signal is turned off whenever the robot docks. The turning on and off of the perimeter signal is typically controlled by the control system of the docking station.

The perimeter signal is turned on once a signal from the robot is detected. This signal is based on turning on and off the charging switch on the robot, at a certain frequency, thus, drawing alternating current from the docking board of the control system of the docking station (the docking board monitors the charging current).

It is also possible to turn on and off the perimeter signal manually, through a switch on the docking board of the docking station. The control system of the docking station can also be programmed to automatically control activation and deactivation (turning ON and OFF) of the perimeter signal.

The docking contacts (or contacts) 22 (Fig. 3) on the robot are made, for example, of stainless steel, and enclose a magnet. The docking station contact leafs are made of, for example, 304 stainless steel (para-magnetic). The leafs are typically mounted on a flexible suspension system. When the contacts get near the leafs, the leafs are pulled by the magnet in the contact, thus shortening the time of semi-contact if the leafs are wet or dirty. This substantially inhibits corrosion, dirt and other particulates from building on the leafs (on a bad, wet contact, some current flows through the water and rapidly extract salts from the water thus creating a non-conductive layer on the contacts that looks like corrosion. Another effect of the magnet is to maintain a good contact if the robot slips back slightly while stopping at the docking station.

The robot can be set to resume operation (or begin operation) from the docking station upon a triggering signal, typically recognized by the control system of the robot. This triggering signal can be timed in the control system of the robot, manually sent to or activated on the robot. This triggering signal can also be programmed into the control system of the docking station, or manually sent to or activated on the docking station. The docking station would then send a signal to the robot for its starting up and leaving the docking station to resume operation. The activation of this triggering signal, typically

also turns on the perimeter switch. Activation of the triggering signal can be at any desired time, for example, when mowing is desired. This can be at daily, weekly or even monthly intervals, depending on the kind of mowing needed and the season of the year.

There is also an external trigger connected to the docking board of the control unit of the docking station, that will initiate robot operation, by sending a signal to the control unit of the robot through the docking contacts. This trigger can be connected to an irrigation computer, of a standard irrigation system, such as that for yards, courtyards, gardens, etc. One of the irrigation taps or ports can be set for the robot, and its activation will result in activation (initiation) of the robot for mowing. Accordingly, the scheduling of mowing can be set as one of the taps and programmed together with the irrigation schedule for the yard, courtyard, garden or the like. Scheduling for the activation of the triggering signal can be at any desired time, for example, when mowing is desired. This can be at daily, weekly or even monthly intervals, depending on the kind of mowing needed and the season of the year.

There has been shown and described at least one preferred embodiment of a docking station and robot for use therewith. It is apparent to those skilled in the art, however, that many changes, variations, modifications, and other uses and applications for the apparatus and its components are possible, and also such changes, variations, modifications, and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention, which is limited only by the claims which follow.

What is claimed is:

1. A robot comprising:

at least one contact, at least a portion of the contact extending from the robot;

a control system in communication with the at least one contact;

a power supply for the robot, the power supply in communication with the control system and the at least one contact, and

the control system is configured for permitting recharging of the power supply through the at least one contact when a predetermined voltage on the at least one contact is detected.

2. The robot of claim 1, wherein the predetermined voltage is at least a threshold voltage.

3. The robot of claim 2, wherein the threshold voltage is approximately 25 Volts.

4. The robot of claim 1, wherein the at least one contact includes two contacts.

5. A docking station comprising:

a portion configured for receiving a robot; and

a system for providing power to the robot for recharging the robot, the system including receptors configured for contacting at least one docking contact on the robot and transmitting a predetermined voltage therethrough.

6. The docking station of claim 5, wherein the receptors include at least one leaf.

7. The docking station of claim 5, additionally comprising:

a control system in communication with the power providing system, the control system configured for communication with at least one tap of an irrigation system, the tap being timer controlled, and coupled with the receptor for sending a signal to the robot for initiating operation of the robot.

8. The docking station of claim 5, wherein the predetermined voltage is at least a threshold voltage, that causes the control system of the robot to recognize docking between the robot and the docking station to initiate recharging of the robot.

9. The docking station of claim 5, wherein the at least one docking contact on the robot includes two docking contacts and the receptors of are configured for contacting the two docking contacts on the robot and transmitting the predetermined voltage therethrough.

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